

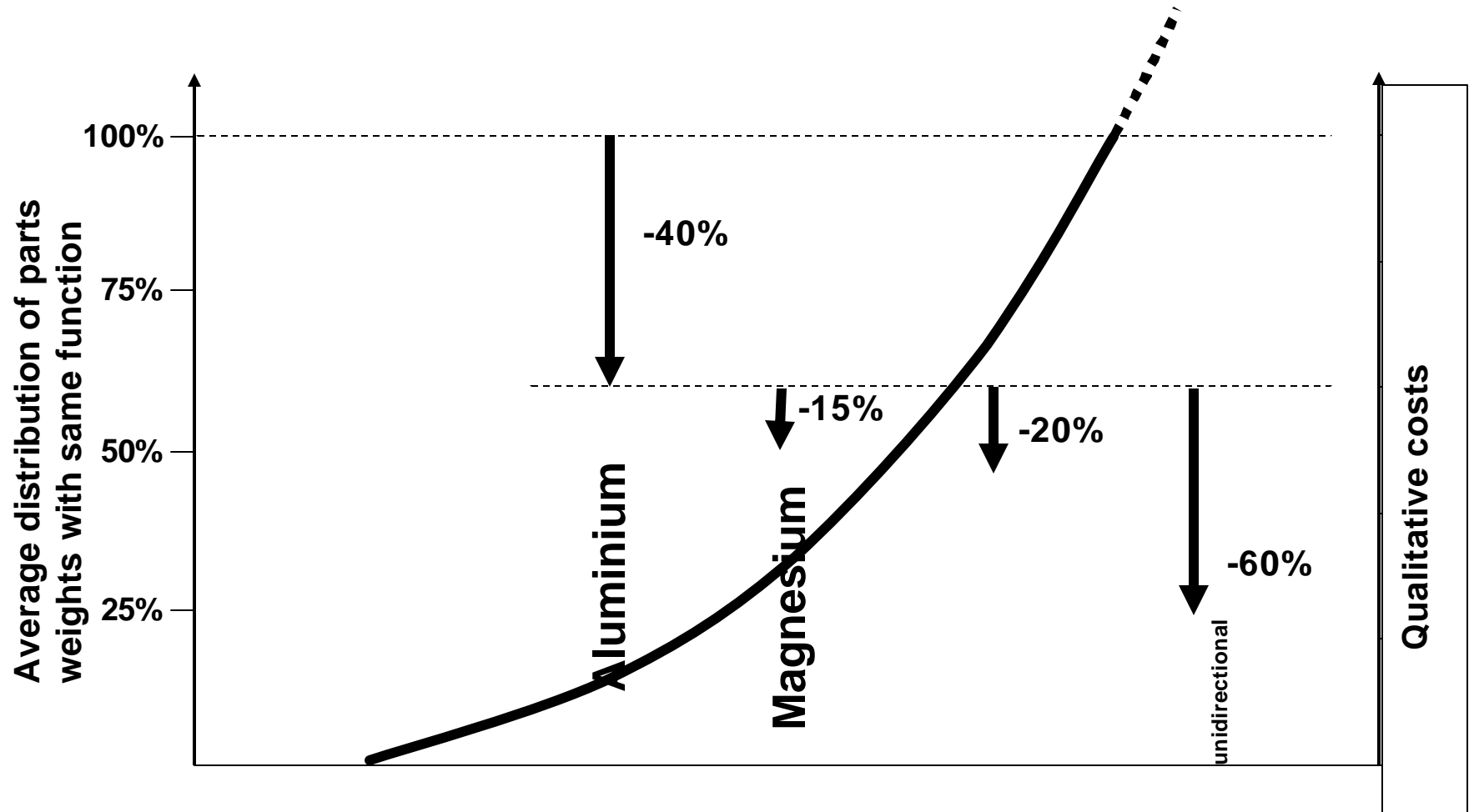
Volkswagen Group of America - EEO & CARB Lightweight - Initial Analysis

May 18th, 2010

Agenda

- Remarks to the Lotus down weighting study
- Contribution of mass to CO₂-emissions
- Main findings of EUCAR SLC study
- Summary & Conclusions

Lightweight potential by material substitution

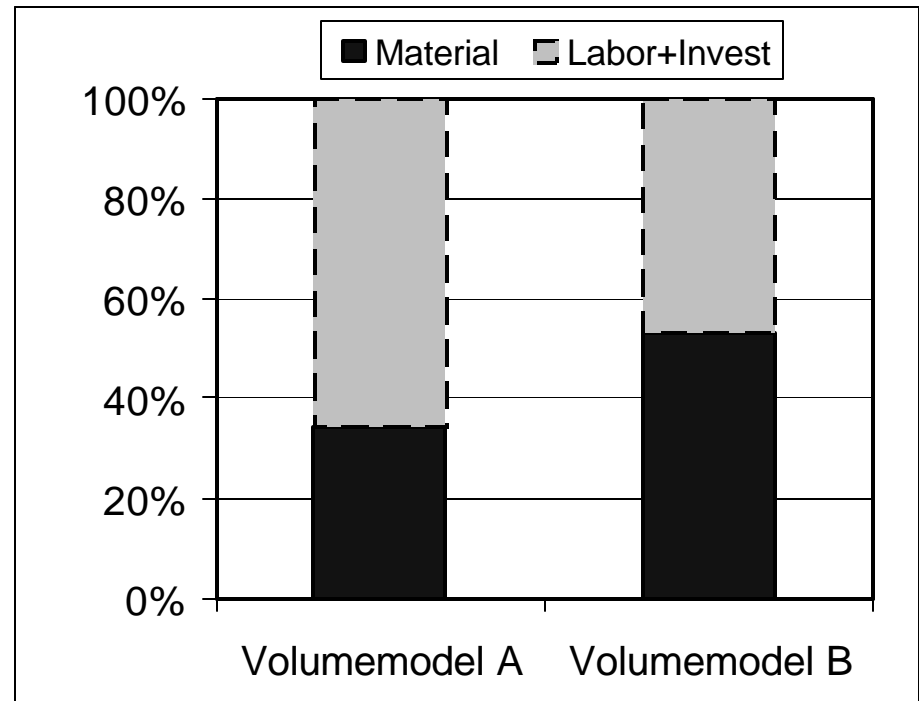


Lotus Study: costs

Remarks:

- Cost-effectiveness of each part can only be decided after all costs are known
 - Labor and Investment costs need to be considered
 - Future development of Material Prices need to be considered, connection to energy prices and recycling costs
 - Cost-effectiveness is a case by case decision and strongly influenced by volume scaling effects

Example of cost distribution if one takes 100 kg out of the car.



Costs per part: Material + Labor + Investment

For total costs, the Lotus study needs to at least double the given material costs

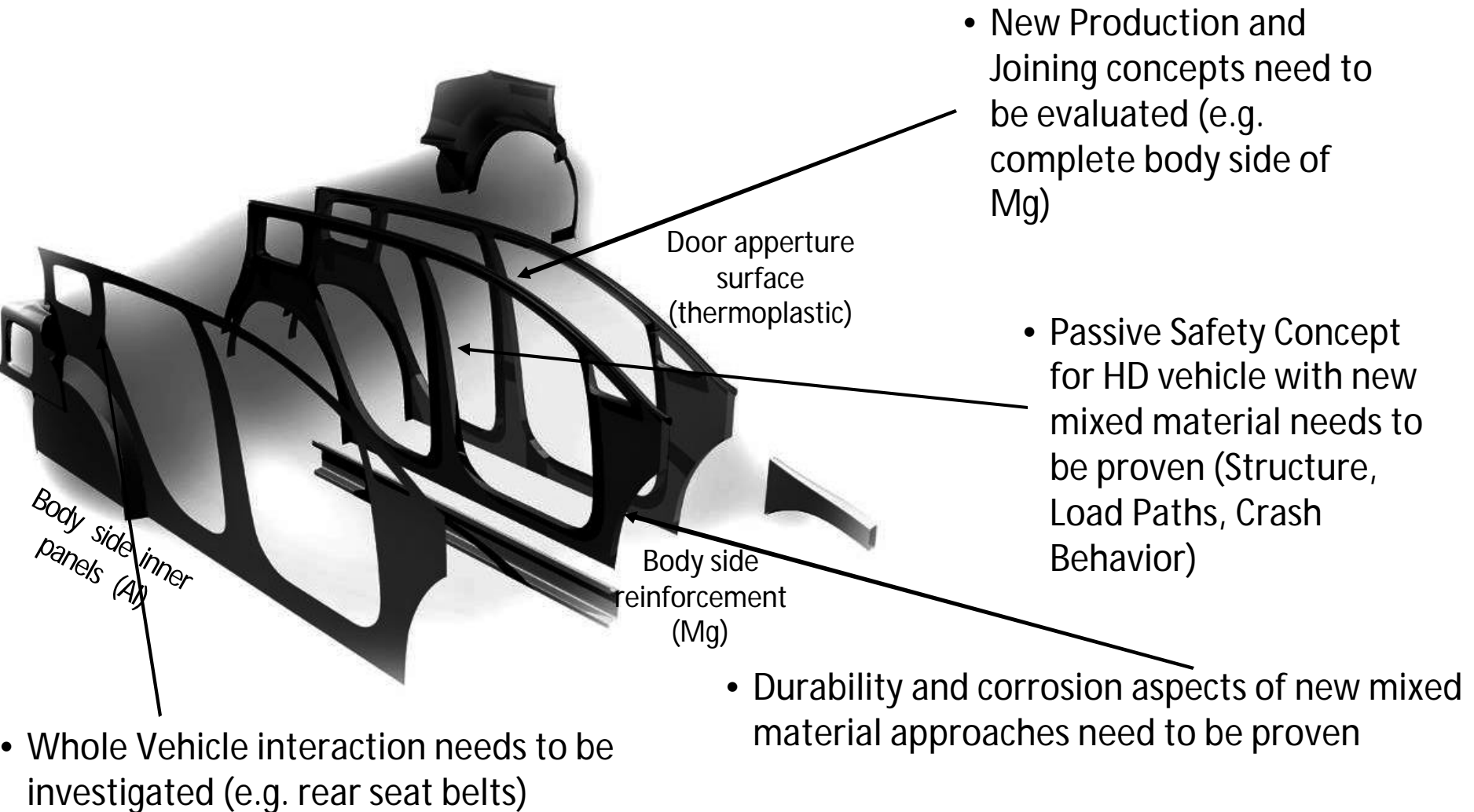
Lotus Study: HD – Floor and Underbody

Remarks:



- Passive Safety Concept for HD vehicle with new mixed material needs to be proven (Structure, Load Paths, Crash Behavior)
- HD concept: Consequences of increased Track Width and Wheel Base onto Torsion Stiffness of car body need to be evaluated

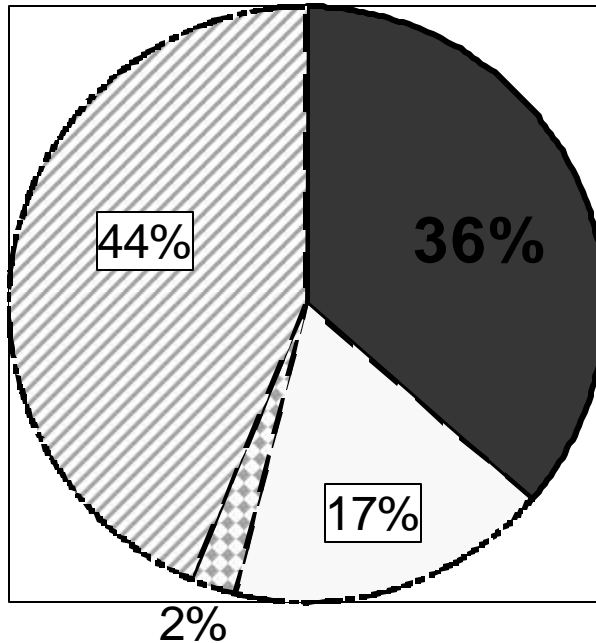
Lotus Study: Body Side HD



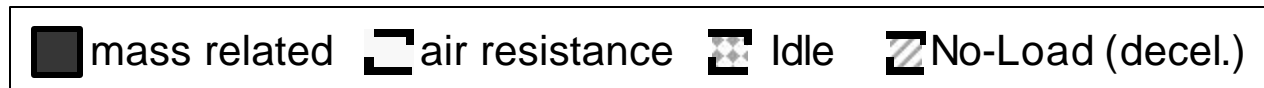
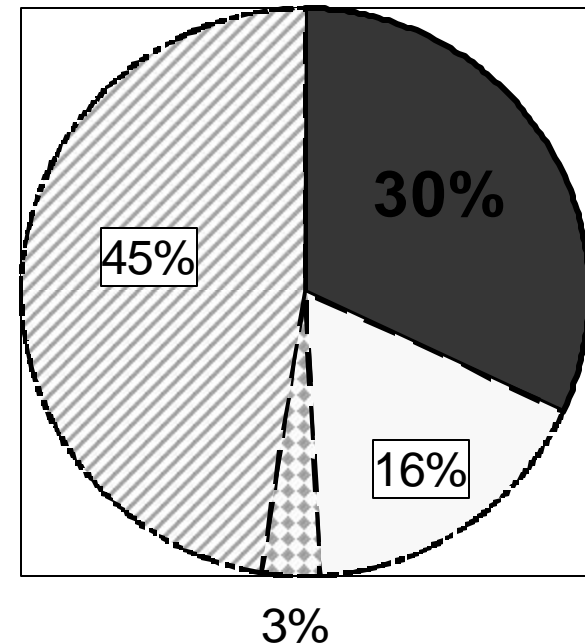
Influence of down weighting in FTP & HFET combined

Contribution of mass related CO₂-emissions

Audi Q5 2.0 T 4500 lbs



Audi Q5 2.0 T 3500 lbs



36% of CO₂-emissionen in combined cycle
are mass related @ 4500 lbs

30% of CO₂-emissionen in combined cycle
are mass related @ 3500 lbs

Super Light Car Program (EUCAR)

Results:

- 35% Body In White (BIW) weight reduction realized on 2005 VW Golf body
 - 100 kg weight saved on BIW from steel reference body
 - Final body concept has a high level of mixed materials (36% Steel, 53% Aluminium, 7% Magnesium, 4% Plastic)
 - Body computer modeled for crash analysis
 - verification on real body open
- Body part cost for BIW is +112% over reference body
 - This yields a 7.85 Euro/kg light weight cost for body parts only



VW Group analysis

- SLC project did not consider full joining costs, assembly cost, tooling cost and factory alterations to accommodate new materials
=> True cost/kilogram will be doubled
- Percent weight reduction of total vehicle due to the SLC measures will be significantly below 10% for the whole vehicle
- Additional concern with cost and sources of aluminum and magnesium in the future considering increasing demands

Down weighting

Summary and Conclusions

- both studies (Lotus and SLC) focused only on material costs and left out 50-65% of the total costs and need to consider these for a complete evaluation
- the weight reduction achieved in the SLC study was about 100 kg for BIW and is in the same range as the low development (LD) vehicle of the Lotus study but with more than doubled material costs
- Vehicle mass contributes in the order of one third to CO₂-emissions and depends on car size/weight level and decreases with the degree of light weight already applied to the base car
- The HD-concept needs to be put into the next phase of developing process: crash-simulations and a real prototype to evaluate the impact of safety regulations (FMVSS and NCAP)
- Volkswagen supports down weighting as a promising tool to further reduce CO₂ and criteria pollutants, but recommends a reconsideration of the presented weight reduction potentials and costs in the Lotus study for the HD-vehicle.